CHAPTER VII

Summary, Conclusion, and Scope for Further Work

7.1 Introduction

Objective of the research was to make a detailed study of supply chain management problems for a typical Indian refinery. Methodology used for the study was splitting the problem into small modules of structured, semi-structured, and unstructured parts and then finding suitable solutions for the problem. All those solutions were implemented together with suitable linkages to get the final integrated supply chain for a refinery. The methodology was suitable for finding the solutions and it was established by the application to an existing refinery. Logistics of a refinery is a complicated subsystem in its supply chain. This was studied in detail. The study was started at the beginning of Government decontrol of petroleum industry. Complete decontrol is not yet over. So its impact is not yet completely clear to the industry.

7.2 Summary

Existing literature on SCM related to the present work was reviewed and is given in chapter two. It revealed the scope for SCM application for a refinery. Though many works had been carried out, an integrated approach was not found. Efficiency of SCM is on the integration of supply chain operations. Present work is in the direction of integrating all the operations using information technology. As per the literature, location is the most important factor for a refinery logistics. To identify a location for a refinery, the knowledge on the petroleum refining, quantity of crude oil available, transportation of crude oil, trade practices, place of availability of crude oil, place of consumption of crude oil and products, mode of transportation, pricing mechanism, and methods of refining are essential. So the relevant practices and data were presented in the beginning of chapter three. This gives an insight to the supply chain practices of petroleum refining industry.
The data presented reveals the potential for further addition of refining capacity. For adding capacity the first step is identification of location for a refinery. With that knowledge in trade practices, some locations could be identified all over the world for setting up a refinery. The procedure for selection of location is given below. A method for selecting location for a new refinery was identified. All the locations identified were analysed for the suitability using a pass/fail criteria. At this stage, places which are evidently unsuitable were eliminated. Then the logistic cost for each location was calculated for eliminating with very high logistic cost. Then factors for selection of location were identified. A weightage table was developed for reducing the number of factors. Those selected factors were compared each other and relative score was awarded. Then a preference matrix was developed to find out weightages for each factor. Those weightages were used to compare the locations short listed. From the comparison a weighted score for each location was calculated and location with highest score was selected for starting a new refinery. Once location is finalized, flexibility and configuration plays important role in the performance of supply chain. Flexibility is important because demand pattern changes among products, new products, etc. Areas that require flexibility were identified and the importance of each area was discussed. This is used while setting up a new refinery because flexibility gives more freedom in product pattern and product specifications. Product specification could be made flexible only through proper selection of technology. So the technologies available were analyzed along with their relative cost. A decision on location of refinery, flexibly required, and technology needed to give the required flexibility can finalize the design of a new refinery. Major problem in an existing refinery is related to planning. Next section discusses logistic planning required for a refinery.

Logistic problem was divided in to two stages namely design and planning. Areas, which can not be improved after installation, are design stage problems. Planning is done for both facility design and operation. For improving the effectiveness of planning, it was again sub-classified in to annual plan, rolling plan, and daily plan. Decisions to be taken at each level were identified in the
plan zone with respect to inbound logistics, internal logistics, and outbound logistics. A hierarchical planning model was developed for giving a clear picture of decisions to be taken at each stage. This will also give an idea about the source of input data for planning. Source of information can be either from previous plan period or from outside the planning system. Model developed was helpful in maintaining the sequence in planning. Tools required for planning at each stage were identified and separated in to annual planning, short term planning, and daily planning. These were given in table form for the easy reference. Demand forecasting was the first stage in planning. Demand for refined products was not the same every month. It was changing with seasons and socio-economic conditions. So a model was developed to make the forecasting better and more reliable. In the model, consumption of products in the previous years was taken as the input data. A six-step mode of demand forecasting was developed for the implementation in a refinery. Linking of forecast with all planning areas of supply chain was essential for better planning. This six-step approach was helping in achieving it. Crude selection and purchase was another important function in a refinery. Crude selection was made on the basis of product demand and facility constraint in and outside the refinery. Due to the linear nature of the problem a Linear Programming Problem was formulated to solve the problem. Maximizing netback is the objective function. Each refinery will have different set of constraints. An example of Kochi Refinery Limited (KRL) was taken for verifying the application and gain of the models. Bringing crude oil to the refinery was the next important function. This function had a number of variables like tide in the port, seasons, etc. A simulation model was developed for ship scheduling. The model gives the number of ships to be brought and their cost for bringing crude oil. This model was used as DSS for ship selection with minimum demurrage payment to the shipping company. Internal logistics planning procedure was also discussed in this section to reduce starving and blocking of facilities in the refinery. In a refinery, the facilities were tightly coupled so the freedom for flexibility was limited for logistic purposes. Modes of transport for product in outbound logistics were also analyzed and a model was developed for selecting a mode of transport to a particular place for definite quantity and variety of

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products. These models will help in developing systematic planning procedure in inbound, internal, and outbound logistics. Exponential smoothing method used for calculating demand was found very appropriate and six-step method of demand forecasting was useful for the industry. LPP used for crude oil selection was also found to be very useful for a stand-alone refinery. Simulation model used for ship scheduling can be used as DSS. All these together make the inbound logistic activity of a refinery very strong. Application of information technology in a refinery for the performance improvement in SCM is discussed in the next section.

In a supply chain management system there are three key components. They are information flow, material flow, and cash flow. Success of SCM is the systematic control of all these flows. Standard methods are there for improving material flow. Better technologies are there for faster information sharing and use. Effective banking systems are there for faster transactions. But better monitoring and control is required to reap the benefits of SCM systems. Planning and control functions performed by logistic managers rely on quick and accurate relevant data. Building an Information System for data capture, storage, and use is the pre requisite of a good modern Supply Chain Management System. Information technology is the backbone of integration of information. Information sharing can improve the productivity and reduce level of inventory at all stages. An efficient software system is required to support a well-designed supply chain management system. The software system must have a very good data collection facility from the source of data as much as possible. Single point data entry is the next stage if direct collection is not possible. Software system model must support all the functions in the refinery. The main functions in a refinery are process control and monitoring, operations management, and business management. Identified key features of software system must be there in the software to be finalized. The strength and utility of any software system is the integration of all functions in a refinery. In other words dispensing retail outlet to crude oil and chemical suppliers must be integrated through communication systems to improve the quality of service and reduce the working
capital requirement. This will improve the profitability and competitiveness of a refinery. All the processes were subdivided into small subgroups and information required and generated was analyzed. All those subgroups were joined together to form an integrated information flow model. This will provide reliable and fast information in decision making as well as for operations. Software available in the market was analyzed and a comparative study was included for taking a decision on selection of information system if a refinery is interested in buying one. All those tools developed and selected were used in a stand-alone refinery. Results of the applications are given in the next section.

All the logistics operations performed by Kochi Refinery Limited were analyzed and suggestions were given for improvement. It was started with the selection of crude oil and finished with the retail outlet. It was proved beyond doubt that crude handling operations, especially the limited crude pipeline capacity was the most serious bottleneck at KRL. Four temporary solutions were suggested (i) use of drag reducers (ii) getting Suez-max tankers to bring crude (iii) using the black oil pipeline available to pump in crude when it is not in use for product movement. (iv) Install a booster pump in the crude line at the pit-head at the KRL tank farm. This will boost pressures from there and will take up the pressure needed to pump the crude into the tanks. The permanent solution to this problem is the Single Point Mooring system that KRL is currently examining. From the past freight data for crude tankers it could be seen that R N Tagore, Iswari, Sravanan, BC Chattergi, and S Sarma were relatively more expensive ships and hence they should be avoided. A peculiar thing noticed was that all foreign crude tankers had lower than average discharge rates, and this should be looked into. Other SCI vessels with low discharge rates should also be avoided. The simulation experiments of crude unloading operations show that the cost of unloading operations goes up linearly if more than sixteen tankers bring crude every month. Crude tank inspection and repair takes a very long time leading to loss of tankage. The loss of tankage on this account was from one third to one fourth of the total built up tankage. This have to be reduced to improve tankage availability. The arrival of crude was varying in most months, that one type of
crude was there in very high quantity at a given time. A comfortable stock of BH, PG-HS and PG-LS crude was not steadily available throughout most of the months, limiting processing flexibility. The crude stock build up for monsoon was done too early, in the months of March, April and May. It was found that refining was the strong point of KRL. The production and dispatch of most products were well aligned that inventory build-up was not very high (this could be because KRL was forced to align production and dispatch because of low product storage facility available). The product tankage requirements for KRL were not sufficient for most products. This was most critical for HSD. There was automatic tank gauging system in place, which was being utilized to a great extent. However, procedures many a time requires manual gauging to be still done, this should be reduced and manual gauging should only be done for calibration and accuracy checking of tank gauges periodically. It was known that wherever manual blending was done as in KRL only a few regular blending options were tried out. This limits the gain that could be obtained from blending operations. Manual blending offline also requires more tankage for storage. KRL must go for on line blending systems in overcoming this problem.

Product dispatch by tankers is crucial for KRL, late tanker arrivals result in ullage problems, and forced reduction of refinery throughput. Hence KRL should more closely monitor product movement by tanker. A system of sharing data regarding product tank positions between oil marketing companies and KRL can go a long way in enabling KRL to lessen the problems it has due to limited product tankage. The operations at wagon loading need to be improved. With some streamlining, the amount of products dispatched by this route can be increased. The problem in this area will be mainly HR. There is also the problem of bad wagons coming for loading that has to be sorted with the railways and a solution to the same must be found out. The new truck loading facility is currently underutilized because of process bottlenecks in the procedures before and after loading. This has to be studied in detail and measures to remove the bottlenecks must be found and implemented. The accounting department faces problems because they have to rely on figures of stock and sales reported by Stock...
and Oil Movement, and Computer and Automation departments. These figures are often inconsistent and require modification later. The need to re-key this data in different computers because of lack of an integrated information system, is a serious problem here. With changes taking place so fast people need to be trained in areas such as international finance, Oil market operations, and shipping and related rules, to handle problems in these areas effectively.

7.3 Limitations of the Work

Data collection for the case study was mainly done in the time of Administered Price Mechanism scenario. Changes can be expected in post Administered Price Mechanism scenario. This will change the supply chain system. Distillation process is automated in the refinery under study. So optimization of distillation is not attempted. In the refinery, blending of products is done in the storage tank. Online blending at the time of product delivery is suggested for increasing product flexibility. In blending a lot of research had been carried out and standard practices are evolved. So no attempt is made to optimize blending process. Method for solution to the location problem is derived through a sequence of calculations. The whole problem can be solved using a computer programme and it can be converted to a Decision Support System. It is not tried in this research. Flexibility for refinery is solved as sub-systems of the refinery. Even though it is possible to quantify flexibility, it is not attempted in this research work and is one of the limitations of this work. Attempt to make it an integrated solution was also not done. Technology options for a refinery are taken from the published literature only. A detailed survey of technology may give a better result and the cost for adopting technology also will be more realistic. Crude oil selection problem was solved by using data from a stand-alone refinery. The refinery was not permitting to publish the actual data so realistic data is used to solve the problem. Multiple refineries also can be studied for formulating the problem. In the simulation problem discrete arrival of ships were considered but in real life there can be cluster of ship arrival. Seasonality factors like monsoon are not considered in the simulation problem. Supply chain operations related
studies have been related to a single refinery. Marketing and distribution networks have not been studied.

7.4 Conclusions of the Study

Location of refinery has great importance in the SCM problem. Selection of location must consider many factors. So a model was developed for finding out the suitability of location with respect to a few other similar locations. This model will help in finalizing the decision on location. Flexibility must be maximum to compete in the international market. Areas which require flexibility were identified and methods for providing flexibility were suggested to compete in the post APM scenario. Process selection was identified as one of the important factors in setting up of a new refinery. Selection procedure and options available for selection as well as suitability of each process in the Indian context were also discussed.

Planning was divided in to four time periods for improving the efficiency of planning. Planning started with the forecast of demand for products. A mathematical model was developed to improve the accuracy of forecasting. Product demand has bearing on selection of crude oil and crude oil selection is based on many factors. So an LPP was developed for selecting crude oil so as to maximize netbacks. Bringing crude oil to the port of unloading is the next major bottleneck. A simulation based DSS was developed for ship scheduling. The DSS will provide comparison of different ship schedules. Separate planning models for inbound logistic, internal logistic, and external logistics are also developed.

Information technology being the backbone of supply chain management, tools available for use in SCM as well as the suitability of each tool was discussed. An information system model for integrated refinery supply chain management was presented. The whole system was divided in to small operational sub modules and information system for each sub module was developed. Finally all the sub modules were joined together to get the integrated information model for
SCM. A stand-alone refinery was selected for collecting data for analyzing each proposed model. A SWOT analysis was done in KRL to identify the strengths, weaknesses, opportunities, and threats for KRL. Important weaknesses were analyzed in detail. Inbound logistics and outbound logistics were found as week areas and suggestions for improvements were given. Information flow and cash flow were analyzed and some suggestions were given in this thesis. Results of analysis was very encouraging and suggestions for improvement of operations of the refinery is also added in this research.

7.5 Scope for Further Work

The study was conducted in the time of APM dismantling. APM dismantling could not continue in the pace at which it was designed. So the full effect could not be taken into account in this study. When the APM is completely removed, similar study can be done in the future. Export possibility for products can be analyzed in detail after full APM dismantling. Development of software package can be made for the integrated model on SCM and it could be developed as a commercial package, which will be of great use to the petroleum refineries in future for better performance. Scope of strategic supply chain partnerships between crude oil suppliers, refiners, and marketers can all be studied since they are possible in future. Exclusive studies related to possibilities and profits from supply chain partnerships and profit sharing in such partnerships are very relevant. Benchmarking type of study to improve supply chain performance can also be done.